Discrete elements: the essence of language? – Comments on the neural side of morphemes and rules

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In linguistics, language is described as a discrete system of lexical elements and recursive rules linking them together in sentences and larger junks of text (Jackendoff, 2002). The notion of discrete representations has, however, been questioned on the basis of neural networks simulating syntactic and semantic processing (Elman et al., 1996). Fully distributed networks, which map probabilities and process sentence structures to a surprising degree, do not seem to develop discrete representations analogous to lexical entries or to combinatorial rules (McClelland & Patterson, 2002). This situation creates a trench between linguistic and neural approaches to language. The present paper examines whether such a trench is necessary or motivated and finds a clear answer: No.

We first ask whether the absence of discrete representations is a necessary feature of networks. By using networks that are more brain-like than the standard 2 - 4 layer networks employed to approach questions of lexical and syntax processing, we demonstrate that both lexical units and syntactic rules emerge if relevant features of brain anatomy and function are mirrored by neuronal networks (Knoblauch & Pulvermüller, 2005; Garagnani et al., 2008; Pulvermüller & Knoblauch, 2009). A digression will highlight how rule mechanisms may interact with neuronal dynamics and feedback regulation to yield a neuronal device equivalent to a pushdown memory (Pulvermüller, 1993; 2003).

A second empirical part will ask whether we have evidence for the existence of discrete units at the lexical and syntactic rule level. This will culminate in a brief review of recent results from the Cambridge lab that provide neurophysiological (EEG, MEG) support for discrete functional units in language processing (Pulvermüller & Assadollahi, 2007; Pulvermüller et al., 2008; Garagnani et al., 2009).

In conclusion, computational and neuroscience results show that the brain’s language system includes an assembly of discrete neuronal lexical representations (words and affixes) plus a set of discrete neuronal combinatorial rules. Discrete neuronal words and rules may well be the essence of language. Developing mechanistic models of these entities may be critical for advancing the cognitive neuroscience of language.


